RAISING CATFISH IN BRACKISH WATER

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ABSTRACT

This paper includes a discussion of catfish culture studies conducted on Rockefeller Wildlife Refuge in the brackish marshes of Southwest Louisiana.

It points out that channel, blue and white catfish may be grown in coastal waters too saline for other agricultural crops. The channel catfish proved to be the most hardy of the three species, contrary to common belief, and would give the best returns to future fish farmers in coastal areas for one to two years growth.

This data along with that of other workers indicate that it will be necessary to keep the salinity below 8.0 ppt if young fingerlings or fry are reared. Older fingerlings may be grown in salinities up to 11.0 ppt. The highest salinity that we know catfish will reproduce in is 2.0 ppt.

INTRODUCTION

Fisheries research is relatively new to the Refuge Division of the Louisiana Wild Life and Fisheries Commission. Wildlife studies, consisting mainly of waterfowl and alligator projects, have been conducted by this division for several decades and numerous projects have been conducted and are presently underway concerning the various stages of marsh ecology, development and management for wildlife. The uniqueness of this area, the scarcity of fisheries research in this type environment and the excellent facilities prompted the initiation of fisheries work at Rockefeller Wildlife Refuge.

Six years ago, the Louisiana Wild Life and Fisheries Commission in cooperation with the Louisiana State University Agriculture Experiment Station began exploring the possibilities of producing freshwater catfish in brackish coastal waters. It was felt that the warmer climate of our vast fertile coastal lands should offer longer growing seasons and possibly thousands of acres of marshlands now idle may possess a potential to fish farmers. If catfish could be grown in brackish waters unsuitable for anyother crop, then a whole new industry awaits coastal waters. Also, potential inland fish farmers with wells containing certain amounts of salt may be more fortunate than we once believed as this may prove to be acceptable for fish culture and may have some degree of therapeutic effect. The old practice of "salting" diseased fish has been used as a treatment for external parasites since the initiation of fish farming.

Species selected for our studies were channel, _Ictalurus punctatus_, white, _Ictalurus catus_, and blue catfish, _Ictalurus furcatus_. Until these studies were initiated, the production of catfish in brackish water ponds on an experimental basis had not been tried. The initial pilot study was in the form of a masters thesis, Perry, 1967. This indicated that under natural conditions both blue and channel catfish were present in the marsh waters having salinities ranging up to 11.4 ppt (parts per thousand). It was also found that blue catfish were more common in the more saline waters. A ratio of 2:1 existed between the blue and channel catfish in the study area. In a literature review, it was revealed that blue catfish were also dominant in the estuarine waters of the extreme southeastern portion of Louisiana (Kelly, 1965). This data gave us reason to believe that the blue catfish would be better adapted than the channel catfish to saline conditions and may give better growth in brackish ponds.

The white catfish, also a freshwater species was considered for brackish water pond culture studies. This fish is not native to Louisiana, but is found in the coastal Atlantic states, ranging southward from New York to Florida. It is also found in the mid-west and has spread into Nevada and California. The white catfish is reported as being adaptable to a variety of habitats including brackish waters. This fish spawns readily in ponds and responds to supplemental feeding giving a high production per acre (Prather and Swingle, 1960).

The purpose of the pond studies was to determine if these more commonly accepted freshwater catfish could be successfully grown in saline waters and to determine the effects of these marsh waters upon growth, survival, food conversion and palatability.

STUDY AREA

The research ponds used in our experiments are located on Rockefeller Wildlife Refuge in the coastal marshes of Southwest Louisiana (Figure 1). The refuge encompasses 84,000 acres and is owned by the Louisiana Wild Life and Fisheries Commission. This area borders the Gulf of Mexico for 26.5 miles and extends

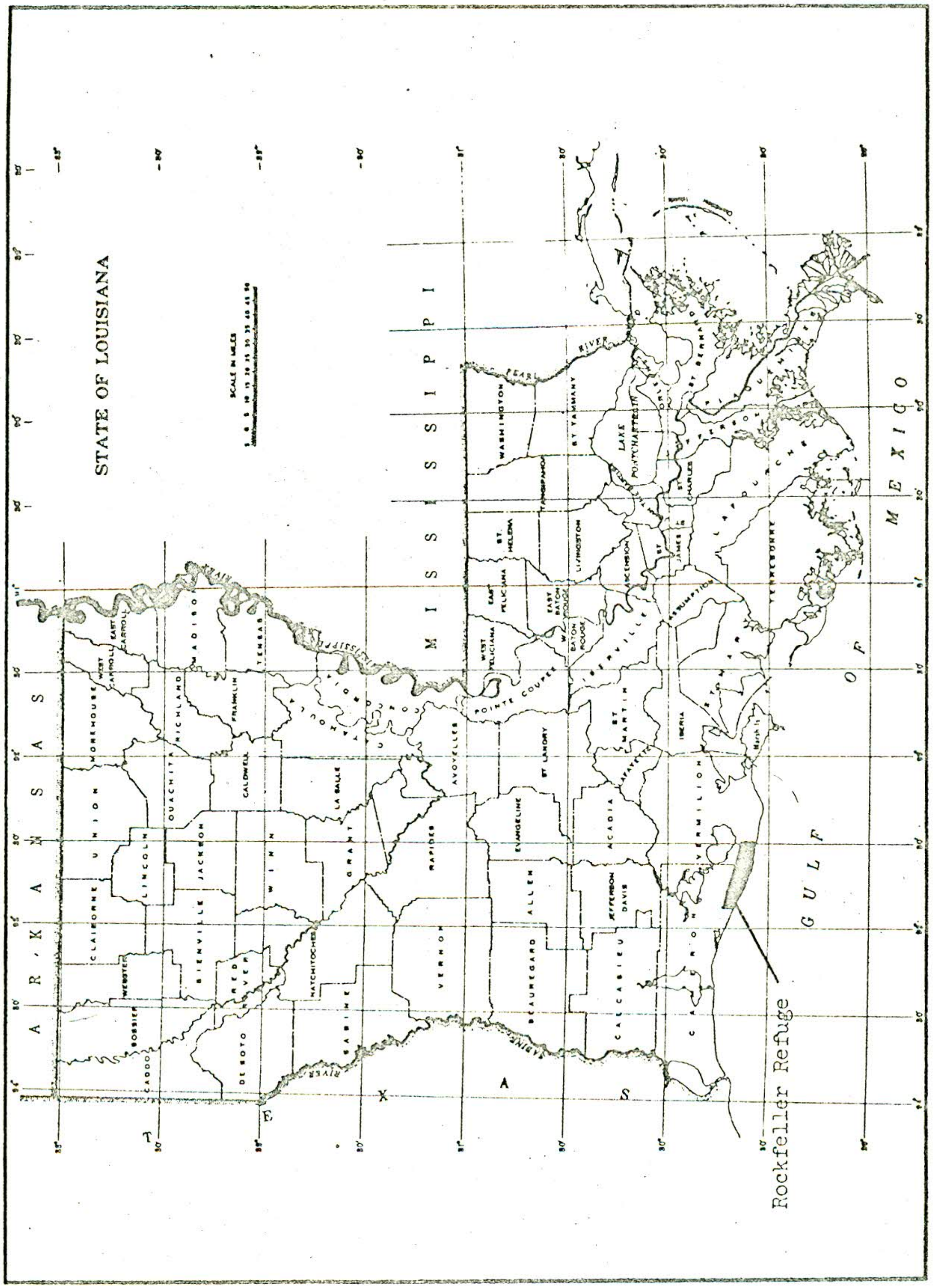


Figure 1. Rockefeller Wildlife Refuge, Grand Chenier, Louisiana

six miles northward to the stranded beach ridge complex of Grand Chenier, Louisiana. The Rockefeller marsh has an average elevation of 1.1 feet above sea level and a tidal fluctuation of approximately 18 inches between mean low and high tides. The salinities of the refuge waters range from 0.1 ppt to 30 ppt. The typical salt marsh flora of wiregrass, Spartina patens, saltmarsh grass, Distichlis spicata, is dominant in the non-impounded areas of the refuge.

The research ponds, one-tenth acre each, are arranged in such a manner as to allow salinity manipulations in order to obtain desired concentrations (Figure 2). The average depth of the ponds is four feet. Pond bottoms have a high organic content identical with the surrounding Chenier Plain marshes (Table 1). Soil classification should probably be termed as a muck-mineral type (Chabreck, 1970). Some of the earlier ponds were dug into the marsh floor; however, this presented two very definite problems which will be discussed later.

STUDY METHODS

Stocking.

The initial pond experiments began in 1967 when nine one-tenth acre ponds were stocked at a rate of 2,000 fish per acre (Perry and Avault, 1968). In the spring of 1968, the study was repeated with the three species (Figure 3), but with a higher stocking rate of 2,500 fish per acre (Perry and Avault, 1969). Only one species was placed in each pond resulting in three replications. All of the catfish stocked originally came from freshwater hatcheries and were stocked into the brackish water

Figure 2. A total of 51 ponds have been constructed on the Rockefeller Wildlife Refuge for fishery studies. These ponds, ranging in size from 0.1 to 5.0 acres, are constructed in such a manner as to allow salt water collection from a tidal bayou leading to the Gulf of Mexico or fresh water from a canal draining the fresh water marshes.

Photo of ponds for figure 2 is enclosed in envelope attached to manuscript.

Table 1. Variations in composite top soil analysis taken periodically from Rockefeller Wildlife Refuge Study Ponds.

Phosphorus	166 - 323 ppm
Potassium	455+ *
Calcium	1080 - 2440 ppm
Magnesium	1000+ **
Organic Material	2.3 - 11.2 %
pH	6.5 - 8.0

* laboratory ran one sample complete which equaled 1280 ppm

** laboratory ran one sample complete which equaled 2640 ppm

Figure 3. Species selected for our studies were blue, channel and white catfish (pictured from top to bottom). These fish were stocked into the brackish water ponds with an equal amount of acclimation.

Photo of these species of catfish [illegible] to be included [illegible] attached [illegible] returned.

ponds with an equal amount of acclimation. Also, a prophylactic treatment of 15 ppm (parts per million) formaldehyde and one ppm acriflavine was given to the fish during transport to the ponds.

Feeding.

Each year the fingerling catfish were started on a 10 per cent body weight ration until they were observed taking feed. At this time the feeding rate was dropped to the standard 3 per cent body weight. In 1967, a sinking ration was used; however, in 1968 a floating ration was fed. A good portion of the sinking type was not eaten by the fish, due to the very mucky nature of the pond bottom and because of the presence of a possible oxygen deficient or dead layer in the deeper areas.

A 5-foot 3/8-inch square mesh treated nylon cast net was found to give best results in obtaining fish for the recalculation of feeding rates.

Water Chemistry.

Initially, salinity data was taken monthly using the Mohr method in which water samples were titrated with a standard silver nitrate solution using chromate as the end-point indicator (American Public Health Association, 1960). A model R-S-5 Beckman salinity meter was obtained and was used during the latter part of the 1968 study. A Precision Galvanic Cell oxygen analyser and the Winkler titration methods were both used in periodic oxygen determinations. A Rayon Model D submersible 30-day temperature recorder and a Taylor Model 76J temperature recorder both were used during the study. Records of the minimum-maximum temperatures were recorded at a depth of 3.5 feet below the surface. This was done to get a more accurate picture of the temperature that the fish actually experienced. Portable colorimetric Hach pH test kits No. 17N and 17H were used for pH determinations. A standard secchi disc was used for the turbidity measurements. Pond waters were chemically analyzed by the Louisiana State University Feed and Fertilizer Laboratory.

Harvest.

The water had to be pumped from the ponds since they were constructed below sea level. The fish were collected and held in separate holding tanks until the ponds were empty. Then, total and standard length were measured to the nearest millimeter and weights were recorded to the nearest gram for a comparison of the catfish species.

RESULTS AND DISCUSSION

Harvest.

Pond waters were generally less saline in 1968 (Table 2). The average pond salinity was 6.2 ppt when the fish were stocked. An average high of 6.8 ppt existed in June which declined to 4.1 ppt at harvest. The 1967 average salinity was 2.0 ppt when the fish were stocked. In the months of September and November the average rose to 9.7 ppt and declined to 7.8 ppt at harvest. The two highest readings for the entire study were recorded in July when two ponds contained 11.2 and 10.1 ppt. The average salinity per pond was rather constant among the ponds although there was a wide monthly variation. This wide variation in salinities was a result of rainfall, the number of times the ponds had to be refilled due to evaporation and because of water replacement in oxygen definient ponds.

Table 2. Salinity data in ppt of catfish ponds, Rockefeller Wildlife Refuge, 1967 - 1968.

1967

Pond	April	May	June	July	August	September	November	January	Average per Pond
B 7	2.4	3.3	7.8	7.9	6.7	10.1	11.2	7.9	7.2
B 8	1.8	2.5	7.8	8.9	7.9	10.1	10.1	7.9	7.1
B 9	2.2	2.9	5.6	7.9	7.9	8.9	9.0	6.7	6.4
B 10	2.0	2.7	7.8	7.9	7.9	10.1	8.0	7.9	6.8
B 11	1.8	3.5	8.9	7.9	6.7	8.9	9.0	7.9	6.8
B 12	2.2	3.7	6.7	7.9	6.7	10.1	9.0	7.9	6.8
B 13	2.0	3.2	7.8	7.9	6.7	8.9	9.0	7.9	6.7
B 14	2.2	3.2	7.8	11.2	9.0	10.1	10.1	7.9	7.7
B 15	1.8	3.2	7.8	10.1	6.7	10.1	10.1	7.9	7.2
Monthly Average	2.0	3.1	7.6	8.6	7.4	9.7	9.5	7.8	7.0

Table 2 continued.

1968

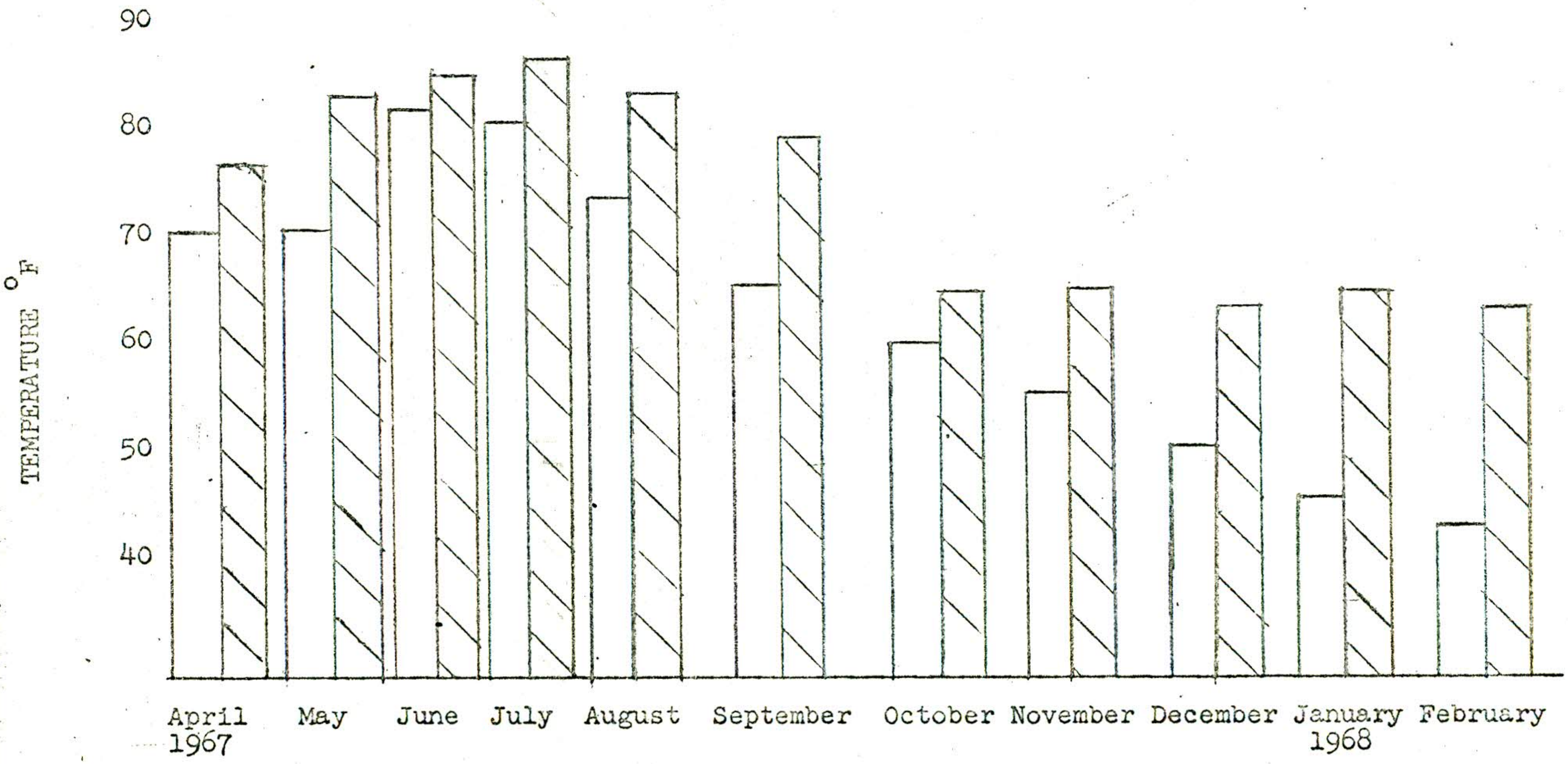
Pond	March	April	May	June	July	August	September	October	November	December	Average per Pond
B 7	7.0	6.5	6.3	6.1	6.0	5.7	4.4	4.6	4.1	3.8	5.4
B 8	5.9	6.4	6.9	7.1	6.8	6.9	5.5	4.6	4.0	3.7	5.8
B 9	6.0	6.6	6.5	6.1	5.9	5.9	4.9	4.7	4.5	4.0	5.5
B 10	6.1	5.9	5.9	6.1	6.2	6.1	5.9	4.5	4.1	3.9	5.5
B 11	6.0	6.4	6.6	7.0	7.0	7.1	6.9	4.7	3.9	4.3	6.0
B 12	6.0	6.3	6.5	7.1	7.2	6.9	5.8	4.8	4.3	4.3	5.9
B 13	-	5.9	6.6	7.1	6.9	6.9	5.8	5.1	4.0	4.1	5.8
B 14	-	7.1	6.9	7.2	6.9	7.1	7.0	6.9	4.1	4.4	6.4
B 15	-	6.9	7.0	7.1	6.7	6.6	6.7	6.1	3.9	4.0	6.1
Monthly Average	6.2	6.4	6.6	6.8	6.6	6.6	5.9	5.1	4.1	4.1	5.8

The water temperatures of the relatively shallow ponds tended to fluctuate rather closely with atmospheric temperatures both years (Figure 4). Temperatures were always above 41° F. and below 85° F. Pond pH values varied from 7.5 to 9.0. The readings were constantly in the 8.0 to 8.5 range. The waters of the ponds were quite turbid with secchi disc readings ranging from 4 to 13 inches. Chemical analyses of the pond waters revealed a rather constant relationship of the elements which showed some variation (Table 3).

In 1967 with supplemental feeding the channel, white and blue catfish gave a net production of 1,344, 890, and 430 pounds per acre, respectively (Table 4). The channel catfish outgrew the rest averaging 1.3 pounds. The white and blue catfish averaged 1.0 and 0.6 pounds. The S-conversion factors averaged from a low of 3.2 calculated for the channels to 5.8 and 10.1 for the white and blue catfish. The channel catfish also had the highest per cent survival with the blues having the lowest.

The 1968 results followed the same general pattern. However, the average sizes were smaller due to the fact that the 1967 fish were held in the ponds over a longer period of time. The channel catfish averaged 0.8 pound, the white catfish averaged 0.7 pound and the blue catfish averaged 0.6 pound. The channel, white and blue catfish gave a 1968 average net production of 1,808, 1,511 and 1,121 pounds per acre, respectively. Per cent survival was highest for the channel catfish, 91.2 per cent, and lowest for the blue catfish, 46.4 per cent. S-conversion factors averaged from 2.3 for channel catfish to 2.9 and 4.0 for the white and blue catfish.

Figure 4. Monthly minimum-maximum range of temperatures recorded 3.5 feet below the surface of Rockefeller Research Ponds, 1967 - 1968.



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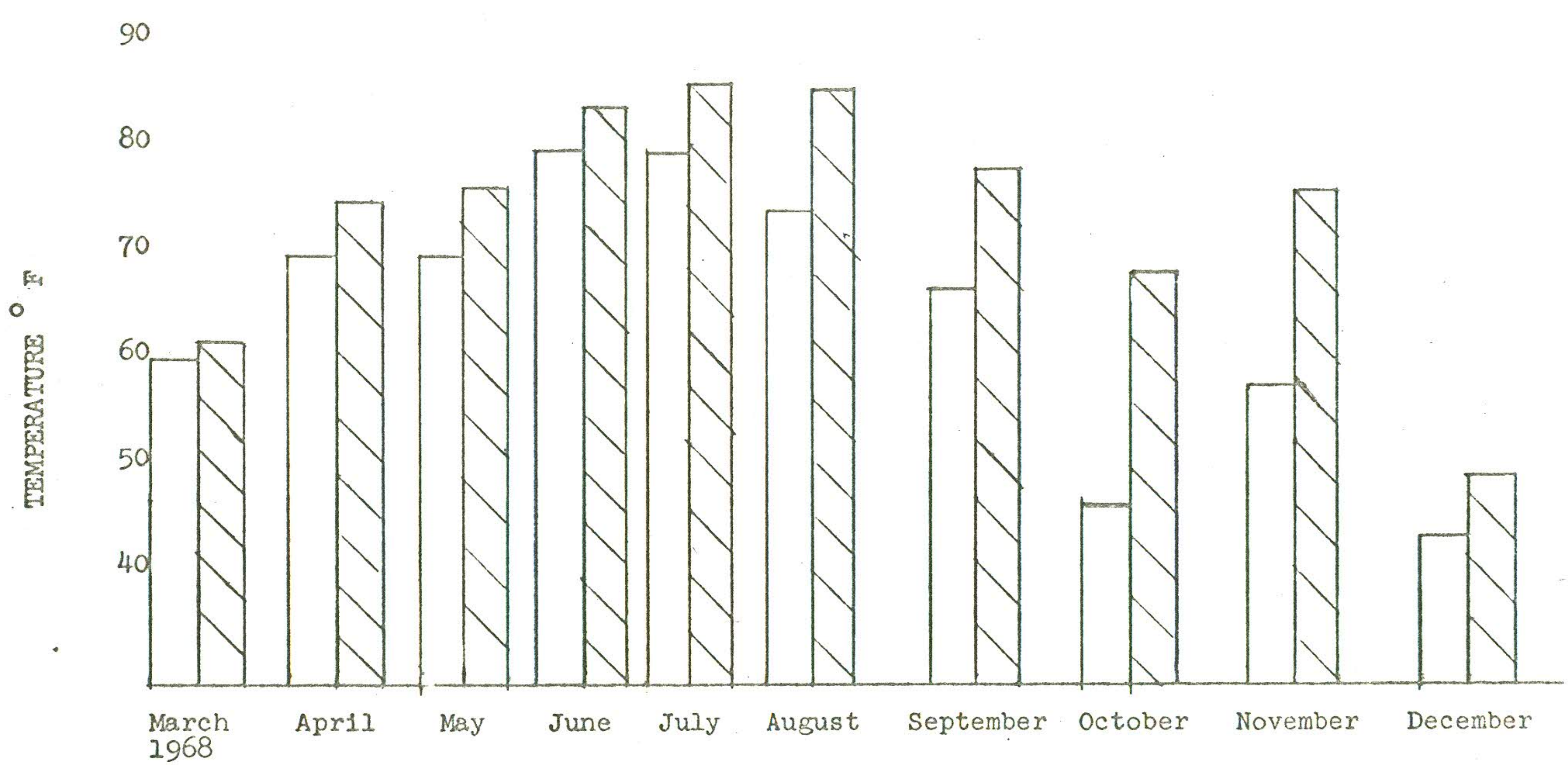


Table 3. Chemical analysis and variation of pond waters from Rockefeller Wildlife Refuge.

Nitrogen	8 - 20 ppm
Phosphorus	0.4 - 11.5 ppm
Potassium	30.0 - 94.0 ppm
Calcium	33.0 - 107.0 ppm
Magnesium	125.0 - 245.0 ppm
Total Hardness	760 - 1480 ppm
Salinity	1.8 - 11.2 ppt
pH	7.2 - 9.0

Table 4. Growth data for blue, channel and white catfish grown in 0.1 acre brackish water ponds, Rockefeller Wildlife Refuge.

	White Catfish		Channel Catfish		Blue Catfish	
	1967	1968	1967	1968	1967	1968
Number Stocked per Pond	200	250	200	250	200	250
Average Weight Stocked (lbs.)	8.0	9.0	7.1	7.3	5.6	10.8
Average Size Stocked (lbs.)	.040	.036	.036	.029	.028	.043
Average Weight Recovered (lbs.)	80.9	151.1	134.4	180.8	43.0	112.1
Average Size Recovered (lbs.)	1.0	0.7	1.3	0.8	0.6	0.6
Survival Percent	39.3	86.0	53.6	91.2	34.0	69.6
S Conversion	5.8	2.9	3.2	2.3	10.1	4.0

It should be pointed out that the difference in sizes of fingerlings at the time of stocking did not effect the results appreciably in these studies. In 1967, the average weight of the blue, white and channel catfish stocked was .028, .040 and .036 pounds each (Table 4). In 1968, the average weights of the blue, white and channel catfish was .043, .036 and .029 pound. In 1967, the blue fingerlings were smaller than the other fish and the next year they were a little larger. Both years they gave the least amount of production.

Figure 5 illustrates the comparative growth of the species and the monthly average salinities. We found in our sampling for the adjustment of feeding rates that some months had negative or little growth. There was no way of measuring the same fish each sample period and it is highly possible that runts and hogs were included in the samples.

Laboratory Studies.

Our results have recently been supported by controlled laboratory experiments conducted at Louisiana State University (Allen and Avault, 1969). In this study channel catfish eggs and yolk fry were tested for survival. Fingerlings and yearlings were tested for food consumption, growth, food conversion and survival. It was found that eggs three days old and older tolerated up to 16.0 ppt total salinity. Upon hatching the tolerance dropped to 8.0 ppt. Allen and Avault reported that after yolk absorption there was a slight increase in tolerance to 9.0-10.0 ppt. Five to six month old fingerlings had another increase in tolerance of 11.0-12.0 ppt. They reported no further increase in tolerance beyond six months. It was also found that the

Figure 5. Growth curve of blue, channel and white catfish grown in Rockefeller Research Ponds, 1967 - 1968.

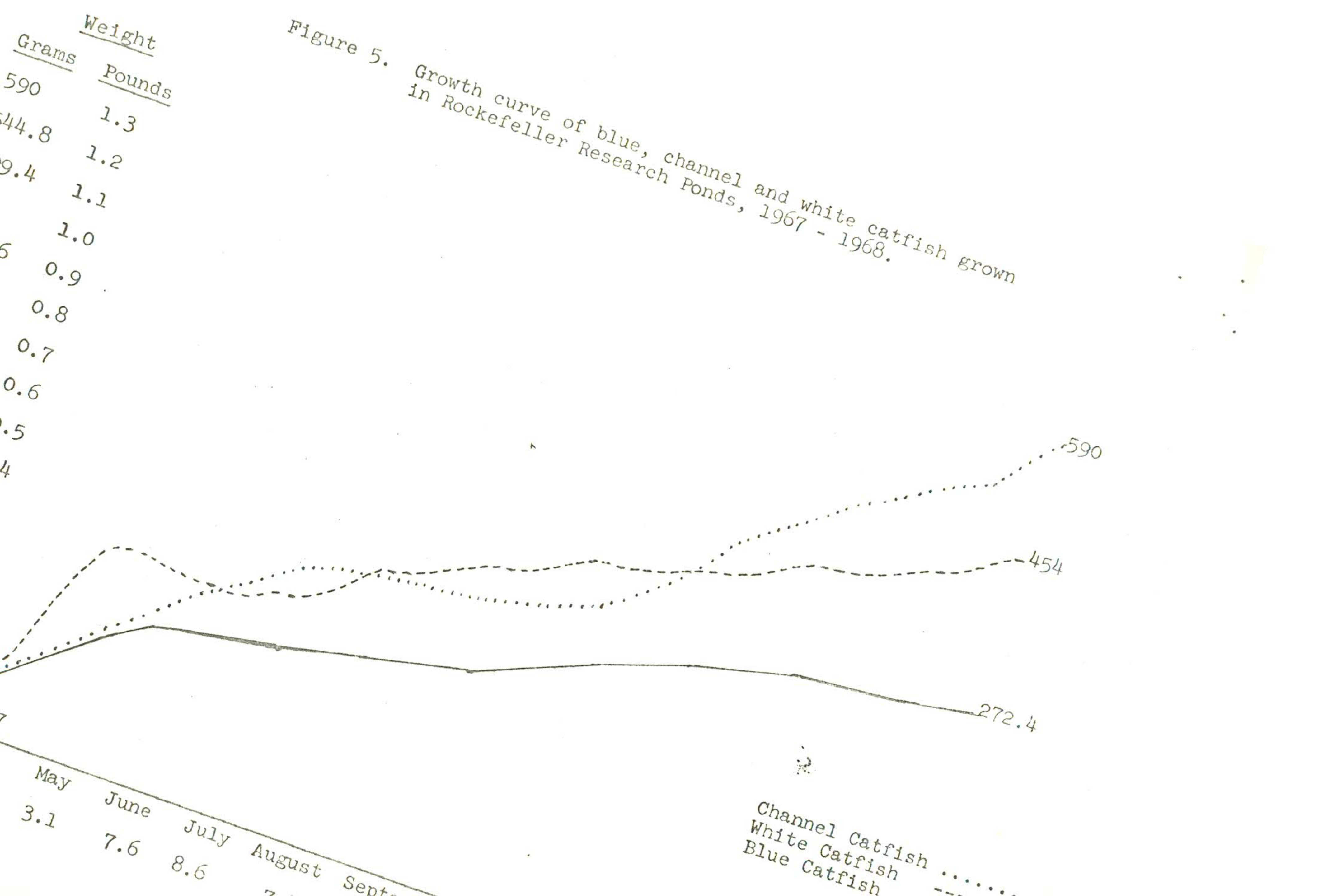
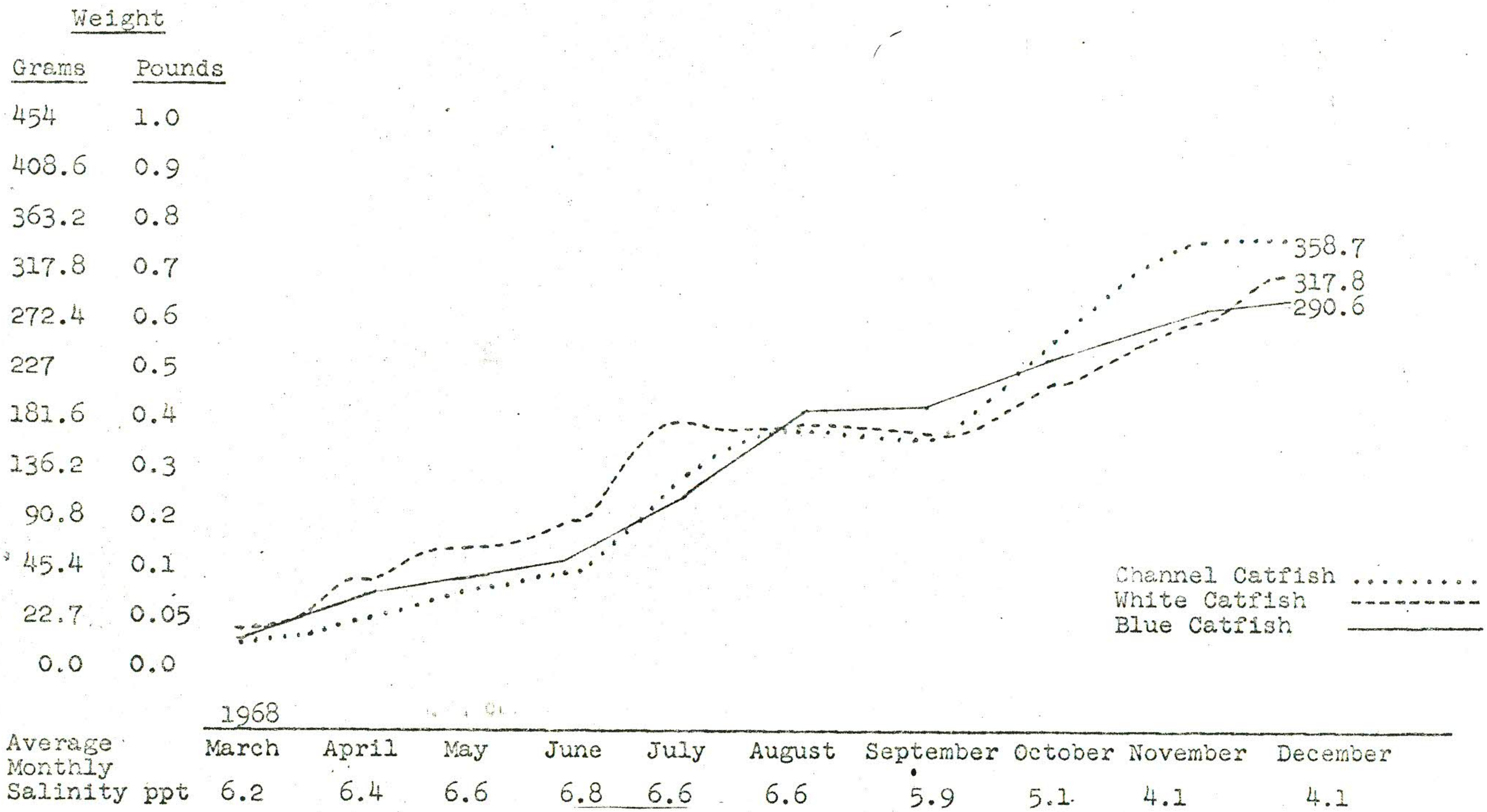


Figure 5 continued.



acclimation of fish to salinity resulted in only a slight (0.5 ppt) increase in salinity tolerance.

In a study of food consumption, growth and food conversion of fingerlings, Allen and Avault found the results to be almost equal in salinities up to 5.0 ppt. In the test conducted in the 5.0 to 10.0 ppt range the fish did poorly. However, it was mentioned that this could have been due to a gill infestation before it was controlled. Salinities of 0 ppt through 11.0 ppt did not seem to have any detrimental effect on 11-14 month old yearling fish when tested for food consumption, growth and food conversion.

Data is still too inconclusive to give results of salinity upon actual reproduction. Experiments are now underway to observe hormoned brood fish in different salinity concentrations. We may find that the fish will not attempt to spawn or that the sperm will not survive in saline waters. However, fish population data collected in connection with other studies and actual observed spawns in our research ponds indicate that channel catfish can spawn in salinities up to 2.0 ppt. Also, one northeast Louisiana catfish farmer whose operation we have recently been observing had reproduction last year in a pond which contained 1.6 ppt salinity.

The effect of sea-water concentration on the reproduction and survival of catfish may follow the same pattern as that described for largemouth bass and bluegill (Tebo and McCoy, 1964). They pointed out that approximately 10 to 12 per cent sea water (3.6-4.3 ppt) was the maximum concentration at which bass and bluegill could successfully reproduce. Fingerlings were found to survive concentrations of 29 to 38 per cent sea water (10.3-13.4 ppt).

Therapeutic Value.

Numerous early observers of our studies suggested that catfish grown in saline ponds may be free of the more common freshwater parasites and diseases, possibly because of a therapeutic effect of salt on the fish. Thus far, we have not had any problems with diseases. However, Dr. R. M. Overstreet, parasitologist with the Gulf Coast Laboratory in Ocean Springs, Mississippi has reported some forms present on our fish that could cause problems if more common. He reported that the only parasite found in our white catfish was a small unidentified helminth cyst in the mesenteries. A light infection of *Trichodina sp.* and *Cleidodiscus sp.* was found on the gills of a blue catfish. Also, he found one copepod, *Ergasilus sp.*, on the gills of a blue catfish and two immature cucullanid nematodes in the intestine. A cestode, *Corallobothrium sp.*, was taken from the anterior intestine of both a blue and channel catfish. A few *Trichodina sp.* were also found on the skin and gills of a channel catfish. None of these were frequent enough to cause alarm.

The only parasite present that has caused us concern was the myxosporidian, *Henneguya sp.* In March of this year, 1970, it was found in a holding pond on approximately 8 per cent of the blue catfish. This myxosporidian is not new to us as it has been seen on native channel catfish taken from the brackish waters of the refuge.

Taste Test.

The pond-reared catfish are generally considered one of the most delicious of freshwater fish. Catfish obtained commercially often tend to have a strong or fishy taste reflecting the prepared some of the fish at the termination of the study in order to find if any of the fish possessed an odor characteristic of the marsh. The results of the test were excellent and none of the fish had a marshy taste or odor.

Marsh Pond Construction.

Catfish culture in the marsh had its problems like anything else. Two of the major problems that we encountered included pond construction and levee erosion. Levees had to be built using either pontoon draglines or conventional draglines on mats, because of the semi-fluid nature of the soil (Figure 6). Our particular area necessitated that we build the levees with soil obtained from outside the ponds. Disturbing the pond floor resulted in a bog in which it was impossible to work. During harvest this was particularly a problem (Figure 7). A maximum levee height of three to four feet during the initial spoil placement was adhered to in order to prevent excessive weight from damaging the foundation of the levee. Also, a berm of at least 12 feet was left on the canal side of the levee to prevent the levee from sluffing. The new levees were permitted to dry for approximately one to two years before they were reshaped and dressed. A finished grade of four to five feet above marsh level with a three to one slope on the pond side and at least a 10-foot crown was found adequate. New levees experience as much as 60 per cent shrinkage due to the semi-fluid nature of the soil. This is a factor which must be considered before any permanent water lines are laid. Maximum shrinkage was during the first two years.

The erosion of levee soil was our second concern. The planting of common Bermuda seed and the sprigging of coastal Bermuda grass seemed to give best results in holding the soils together.

Gravity drainage was practically impossible in ponds equal to or below sea level. Thus, in the harvest of the old ponds it was necessary to go to the expense of pumping. All of our newer ponds are above marsh level.

Predation.

Predation was another problem to us on the wildlife refuge. Otters, mink, frogs, snakes, aquatic insects and fish-eating birds made serious enroads on the fish. The alligator predation problem was not as serious as we thought it might be. This animal is a very inefficient feeder. Of the animals listed, otters were the most detrimental to our fish. Predation by otter was most serious when the fish were sluggish during the colder months. Otters would catch the fish at night and eat everything posterior to the dorsal spine. At first we found from one to five heads on the levees per day. This would develop with time until as many as 20 fish heads could be found on a single levee. Naturally, this hurt our harvest results considerably since we initially stocked 200 - 250 fish per pond.

Summary

In summary, our studies indicate that channel, blue and white catfish may be successfully grown in coastal waters. The channel catfish proved to be the best suited for commercial production in coastal areas for one to two year old fish for the following reasons: (1) the channel catfish proved to be the most rapid growing and the most hardy; maximum production of almost one ton per acre was in a pond containing channel catfish, (2) the channel catfish had the lowest food conversion value of the three, (3) survival was highest for the channel catfish, (4) it is already accepted as a commercial pond specie and is also tolerant of many of the conditions experienced in coastal waters. (Figure 8)

The blue catfish will probably surpass the others in its second or third year. And, if larger fish are desired this specie should be considered. The white catfish, possessing features of both channel and bullhead catfish, might be harder to sell to the public. Some of our older white catfish (2.5 - 3 year old) seem to be developing an unusually large head in proportion to their body. This is a feature desired by only a few of us who enjoy catfish couvillion.

Data is still incomplete as to the effect of salinity on catfish reproduction. The only salinity that we know catfish will reproduce in is below 2.0 ppt. However, this is probably a little low. It will be necessary for a coastal fish farmer to keep his water salinity below 8.0 ppt if he has young catfish fingerlings or fry. If his salinities range from 8 - 11 ppt he will have to start with older fingerlings or yearling catfish.

A prospective coastal catfish farmer will have to know what his yearly salinity variations will be. He must also keep in mind that his pond salinities may increase with summer

Figure 8. Freshwater catfish grown in brackish water ponds at Rockefeller Wildlife Refuge. The channel catfish proved to be the most rapid growing and the most hardy both years; maximum production of almost one ton per acre was obtained in a pond containing channel catfish.

evaporation and he will have to dilute this with less saline water.

ACKNOWLEDGEMENTS

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